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ABSTRACT

This paper reviews the literature and reports on three studies evaluating the use of hypermedia computer study guides or supplementary reading materials with regular students, remedial students, students having learning disabilities, and poor readers. Introductory material explains what hypermedia is and describes typical features. Research supporting the effectiveness of traditional paper/pencil study guides is reviewed and differences between a hypermedia study guide and traditional computer-assisted instruction are noted. Study 1 involved 40 high school students studying Washington State history who received either teacher lecture alone, teacher lecture and hypermedia study guides, or hypermedia study guides alone. Study 2 explored the use of hypermedia study guides as a follow up to teacher-presented instruction, especially with the five lowest-achieving students of Study 1. In Study 1, students who used only the hypermedia study guides performed consistently better than students in the other two conditions. This was true also for students identified as remedial or with learning disabilities. Study 2 also found the hypermedia study guides effective with low-achieving students. Study 3 found positive results in evaluating the efficacy of supplementary hypermedia lessons for elementary students in classrooms using basal readers. The report concludes with five recommended steps in the development of a hypermedia study guide: (1) choose a hypermedia authoring system or language; (2) select and enter the main text passage; (3) decide which words will be hyper-enhanced; (4) decide the type of enhancements; and (5) identify the words which contain links to enhancement. Addresses of hypermedia program sources are attached. (Contains 29 references.) (DB)

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Hypermedia Applications For Content Area Study Guides

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Abstract

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Hypermedia, a new mode of computer text and information presentation, provides a flexible format for adapting materials currently in use by teachers to the computer medium. A hypermedia presentation system provides a reader access to related information by means of a simple selection process. The process "brings up" to the computer screen new windows of related text, related pictures, and computer generated voice that provide supplementary information, clarification, and elaboration needed by the reader, all within in a familiar context and a single medium. The results from two companion studies at the high school level and a similar study at the elementary level indicate that the use of hypermedia to construct computer study guides holds promise. Hypermedia computer study guides were found to be as effective an instructional technique as a teacher presented lecture and were especially successful with remedial students and students with learning disabilities in the high school studies. The elementary school study corroborated the effectiveness of hypermedia study materials with poor readers.

HYPERMEDIA APPLICATIONS

FOR CONTENT AREA STUDY GUIDES

Imagine a book that pronounces unfamiliar words for you. Imagine a book that shows you a picture of almost anything mentioned in the text. Imagine a book that contains related background information from the encyclopedia and dictionary. Imagine a book that provides you with comprehension strategies for understanding key facts and concepts. Imagine that this marvelous book is available today. Well, it is, but not in traditional book form. All these features can be available to readers using a new kind of computer application called *hypermedia*.

Hypermedia is a general term specifying a system for presenting information in a non-sequential, user-selected delivery that can include several interconnected mediums such as microcomputer text , graphic, and animation displays, CD-ROM information storage, and videodisc or video tape film segments or still frames. Hypermedia documents designed for general information retrieval are constructed around a database of information that is accessed through associative links from within the database itself, rather than through key-word searches done from the outside. Educational materials done in hypermedia, however, may be constructed with a more narrowly defined topic and information

links based on pedagogical concerns rather than the less restrictive association-based structure. Although the term *hypertext* was coined first and is sometimes used interchangeably with hypermedia, hypertext refers to a text-only implementation of hypermedia.

When confronted with the traditional print-on-paper format for content area textbooks, students are led through a predetermined, linear progression from the beginning of the reading assignment to the end. Learning is often limited to the information contained in the reading assignment. Any clarification or additional information can only be obtained by consulting supplementary sources (e.g., a dictionary, thesaurus, encyclopedia, or another person). Hypermedia, on the other hand, can provide immediate access to supplemental information that the reader wants or needs without the interruption of seeking additional outside help. A hypermedia textbook might include extra information in the form of additional text, computer generated speech, graphic representations, animated sequences, video segments, or combinations of text, speech, and graphics.

In its most basic form, a hypermedia presentation of information can be compared to one using an overhead projector with multiple transparencies and related overlays. New information, either text or

graphics, can be inserted into the presentation by adding a transparency overlay to the original page. Hypermedia works in a similar manner but the presentation is accessed electronically instead of presented manually. If planned carefully, the supplementary information in a hypermedia document can serve as an electronic study guide, enhancing students' comprehension and supporting their efforts to learn from content area materials.

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insert figure 1 about here

Features of Hypermedia

Figure 1 contains a flow chart illustrating the layered nature of hypermedia. The computer screen shown at the top of the flow chart is a facsimile of a hypermedia page with no overlays visible. The second level of the flow chart depicts screens with hypermedia overlays (usually called windows) that are linked to specific words in the top level screen. These words are linked to the windows containing supplementary information via electronic "buttons". The screens at the third and fourth levels each show an additional enhancement overlaying the screens

from the previous levels. Each new overlay is triggered by a button in the preceding level just as a second-level overlay is activated by a button on the original page.

The screen on the left. This screen is linked to the boldfaced word *solitary*. When the transparent button covering the word *solitary* is activated through cursor selection, a window providing a definition of the word overlays a portion of the screen. A computer-generated voice pronouncing the word may accompany this window. This second-level window may be viewed until the reader clears it from the screen with cursor selection on the button labeled *return*.

The middle screens. These two screens show window overlays at both the second and third levels of a hypermedia document. Unlike the second-level screen on the left, this window is a graphic rather than text and contains a button link to a third level. Cursor selection on the button labeled *more* reveals the third-level window. It provides supplementary textual information about a beehive by overlaying part of the beehive graphic from the second level. Cursor selection on the *return* button takes the reader back to the first level.

The screens on the right. These three screens depict a fourth level of the hypermedia text in addition to the second and third levels

described by the middle screens. A button on the word *hexagonal* on the original page of the text activates a second-level window giving the definition of *hexagonal*. The *more* button in this window triggers a third-level overlay showing a graphic of the geometric hexagonal shape. Likewise, the *more* button in the third-level window activates a fourth-level overlay depicting the hexagonal shape of honeycomb cells and providing a brief explanation. Cursor selection on the *return* button takes the reader back to the original page.

As seen in Figure 1, the layered property of hypermedia can be used to provide readers with supplementary and supporting information in the form of text and/or graphics. In addition, hypermedia has other capabilities that can be used for enhancing text: (a) a network of associative links in which related topics throughout the document are linked via buttons, (b) a note-taking function for compiling information from different areas of the document into one personalized file, (c) a tracking system providing students with the ability to backtrack through a document or locate pages previously read, and (d) a dynamic indexing system for accessing information not already linked to the page being read.

Hypermedia programs containing some or all of these features have been described elsewhere (Anderson-Inman, 1989; Hanlon & Campbell, 1988; Landow, 1988; Wilson, 1987). Some of these materials are large scale information systems designed for relatively unrestrained exploration by students. Others, like the study guides discussed below, are smaller in scale and designed to be used as directed teaching tools. Although this flexibility is one of hypermedia's greatest strengths, the specific features comprising a given hypermedia system are subject to a number of restricting factors: (a) the capabilities of the computer for which the program is designed, (b) the organization of information to be presented, (c) the strategies selected for linking the information together in a logical network, and (d) limitations on the volume of information available.

It is up to educators to determine which of the many hypermedia features available should be included in any given educational application, choosing those that serve a particular population or achieve a specific instructional purpose. More is not always better. Described below is a specific hypermedia application; study guides designed to enhance students' comprehension of content area text material.

Hypermedia Study Guides

The term *study guides* refers to a wide range of techniques and materials designed to support students' efforts to learn content area material presented in textbooks or lectures. In general, study guides attempt to organize the material in a more coherent form or emphasize selected aspects of the information being presented. Three major reasons have been suggested for the efficacy of the successful adaptation of content area texts for students with learning disabilities (Lovitt & Horton, 1987): (a) many students with learning disabilities have difficulty in reading, organizing, and retaining information, (b) many textbooks are poorly organized, and (c) content area teachers with minimal subject matter background find that having organized supplementary material is helpful. Study questions, vocabulary practice sheets, framed outlines, and graphic organizers are all examples of study guides.

In a series of studies at the University of Washington, researchers have demonstrated the effectiveness of study guides through traditional pencil and paper format and computer-assisted study guides. Lovitt, Rudsit, Jenkins, Pious, and Benedetti (1985) developed teacher-directed study guides that presented vocabulary practice sheets and framed

outlines from a seventh-grade science text. Their results indicated significant improvement in the test performance of students with learning disabilities and regular education students when the study guide was used rather than when a traditional lecture-discussion format was used. Bergerud, Lovitt, and Horton (1988) developed study guides that focused on the sequence of main ideas from a life science textbook. Three instructional conditions were compared: (a) graphic organizer study guide, (b) a vocabulary/comprehension question study guide, and (c) self-study. Results indicated that the graphic organizer study guide produced significantly higher test results on multiple-choice tests than did either the vocabulary/comprehension study guide or self study. The vocabulary/comprehension study guide produced higher scores than did self-study for these students. Horton and Lovitt (1989) demonstrated that study guide materials, either teacher directed or student directed, produced improved test performance for students with learning disabilities enrolled in mainstreamed high school social studies and science classes. Not only were the test scores statistically significant, but the study guides allowed the students to be competitive within the content area classroom.

To determine if previous research with study guides could be duplicated using microcomputers, Horton, Lovitt, Givens, and Nelson (1989) developed a computerized study guide for use in a mainstreamed high school world geography class. Results indicated that the computerized study guide was an effective method of instruction for students with learning disabilities and for remedial students. Horton, Boone, and Lovitt (1990) developed hypertext computerized study guides to increase textbook comprehension for students with learning disabilities enrolled in a remedial high school social studies class. The study guides were designed to provide four levels of instructional cues that would match students to their highest level of independent comprehension with a textbook passage. The students with learning disabilities demonstrated significant improvement using the computer study guide and the effects were maintained over a four-week retention period.

Thinking in Hypermedia

A hypermedia study guide is very different from traditional computer assisted instructional software, providing a new format that is concurrently a tool, a tutee, and a tutor (Taylor, 1980). First, hypermedia study guides can serve as a tool by facilitating the collection and

presentation of information that might otherwise require a time-consuming search of multiple sources. Word definitions and spoken pronunciations for new vocabulary along with pictures, animated graphics, or video clips that illustrate processes or concepts being introduced or reviewed can be delivered through the hypermedia format providing students with new experiences related to the topic being studied.

Hypermedia study guides act as a tutee by allowing learner control over the paths they follow and the knowledge structures they create while searching for information. Although a hypermedia study guide may be designed with a guiding structure built in, students still can be given many choices for accessing the information. Students can have control over (a) the order of presentation of information, (b) the number of times information is accessed, and (c) the particular medium through which the information is displayed (e.g., a text definition or description, a graphic representation, a video clip, or digitized sound or voice).

Finally, hypermedia study guides can assist students as a tutor by providing instructional strategies to foster reading comprehension and improve study skills. Adding enhancements that simplify or help students understand the syntactic and semantic structures of content

area text can be included in a hypermedia document along with more traditional comprehension and self-monitoring strategies. Features such as a graphic depiction of the spatial and contextual relationships of pronouns and anaphora to their referent words give students a clearer understanding of text structures that otherwise might be confusing (Higgins & Boone, 1990). Questions inserted in the text, paragraph or page summaries, and pre-reading guides are easily incorporated into hypermedia study guides. The scope and complexity of these strategies are limited only by the capabilities of the computer/authoring system combination being used and by the imagination and skill of the developer.

One version of the strategy for inserting questions in text is outlined in Figure 2. The triangular question icon in the lower right corner of the top screen indicates a comprehension strategy is available on that page. Selecting the question button displays the question bar shown at the bottom of the second screen. The student is told to "Click on the line that answers the question." If the student selects line seven where the answer is located, then the program branches to the fifth screen with the word YES in large letters and the answer highlighted. The student is then returned to the original page.

If the student does not select the correct line, then the page alters itself as shown in the third screen by partially diminishing the text from an area where the answer is not located. This limits the amount of text through which it is necessary to search for the correct line. The student is told to try again. If the student's selection is correct then the lesson branches to the fifth screen. If not, the screen alters again as shown in the fourth screen, this time highlighting the appropriate word or phrase in the text that answers the question. Selecting the line with the highlighted word or phrase will then take the student to the fifth screen.

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insert figure 2 about here

This strategy, an implementation of inserting questions in text, leads students through a thoughtful re-reading process in search of the correct answer. It is a process similar to one a teacher might use in a one-to-one teaching situation with a student and it includes a higher degree of interaction than a multiple choice questioning strategy. The task of developing good hypermedia study guides for educational use

lies in creative thinking and a reevaluation of some of the existing paradigms of instructional design.

Research with Hypermedia Study Guides

During the past ten years there has been a steady increase in the quantity of software available for educational purposes. Unfortunately, for the vast majority of these programs there is little empirical evidence concerning their educational value. Findings from research at the University of Washington, however, indicate that hypermedia study guides can provide an effective learning environment for high school remedial students and students with learning disabilities (Higgins, 1988; Higgins & Boone, in press; Horton & Boone, 1990).

Two studies investigated the use of hypermedia study guides as a substitute for and as a supplement to teacher-presented instruction in social studies (Higgins & Boone, in press). The hypermedia study guides were written for the Apple Macintosh computer in the Guide authoring system (Owl International, 1986). Three high school classes of Washington State History participated in Study 1. This study took place over a 10 day period and involved 40 students randomly assigned to three different treatment groups: (a) teacher lecture only, (b) teacher lecture and hypermedia study guides, (c) hypermedia study guides only.

Study 2 explored the use of hypermedia study guides as a follow up to teacher presented instruction. This second study helped to determine if hypermedia study guides could be effective in bringing the performance of lower-achieving students closer to that required for passing the course. The two studies used the same materials and similar procedures. The textbook from which the reading selections were taken was The Washington Story: A History of Our State (Pelz, 1979).

Three hypermedia functions available through the Guide authoring software were used in designing the study guides for these two studies (see Figure 3).

1. The Inquiry function was used to guide student movement through the text by interspersing multiple choice questions throughout a lesson. Students could not move on to the next screen of text until they had answered the multiple choice question correctly. An incorrect answer routed the student back to the appropriate spot in the text, with the message to try again. A correct answer was reinforced with text and graphics directly related to the question. Students were then allowed to continue to the next page of the study guide.

2. The Replacement function provided students with information designed to enhance their understanding of a specific line of text. Replacement function buttons were indicated in the text by boldface type. When activated, selected text was replaced by a clarifying segment of text or a related graphic.

3. The Note function was used by students to access related information that was not directly available in the book. The presence of notes was indicated in the text by an underlined word or phrase. The related information appeared in a window overlaying the original text and contained either a graphic, text, or a combination of the two.

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insert figure 3 about here

Each study guide consisted of a passage containing 500 to 700 words, divided into electronic pages containing 50 to 100 words. A study guide was designed to be completed in approximately 15 minutes and contained eight multiple choice questions in addition to the Note and

Replacement functions. An average of four Note or Replacement buttons were attached to each page of the study guides. The information contained in the hypermedia study guides was identical in content to that presented by the teacher through lecture, student worksheets, and textbook selections. No computer voice was used in these study guides.

Findings from Study 1 in which students were assigned to one of three separate treatment groups (lecture, lecture/hypermedia study guide, and hypermedia study guide) suggested that the hypermedia study guides were as effective in the delivery of information as a well-prepared lecture presented by a teacher. Students who worked only with the hypermedia study guides achieved higher quiz scores than students in the other two treatment groups for each of the 10 days of the study (see Table 1). When examined by educational group (students with learning disabilities, remedial students, and regular education students) quiz scores again showed higher performance by those students who used only the hypermedia study guides (see Table 2). Specifically, on seven of the ten quizzes, students with learning disabilities in the hypermedia study guide group achieved higher scores than students with learning disabilities in the other two treatment groups.

In addition, remedial students in the hypermedia study guide group had higher quiz scores on eight of the ten quizzes when compared with remedial students in the other two groups. Although it might be assumed that the students who received both lecture and hypermedia study guide instruction would do as well as the students who used only the hypermedia study guides, the difference in the quiz score performance of these two groups may be explained by difficulty some students may have encountered in moving from one type of instructional activity to another within a single class period. Students in the lecture/hypermedia study guide group had to move from a paper and pencil instructional activity (the lecture) to the hypermedia study guide and then back to a paper and pencil assessment (the quiz). This movement was perhaps confusing for some students, thus lower quiz performance.

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insert tables 1 and 2 about here

In addition to the daily quizzes, scores from a posttest immediately following the intervention, and a retention test two weeks thereafter, indicated that the students in the hypermedia study guide

group had a higher overall test mean than the students in the lecture group or the lecture/hypermedia study guide group (see Table 3). While not all of these differences in scores were statistically significant, the consistently higher scores of the hypermedia study guide group are encouraging and give cause for investigation.

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insert table 3 about here

The five students who had the lowest unit test scores at the end of Study 1 were selected for Study 2. During the first study four of these students had been in the lecture group and one had been in the lecture/hypermedia study guide group . The purpose of the second study was to determine if the hypermedia study guides could boost the performance of these low-achieving students past the 50% mark defined by the teacher as a passing grade. Study 2 began four weeks after the conclusion of Study 1 and used the same 10 hypermedia study guides.

Study 2 employed an A-B-A design (Tawney & Gast, 1984). The baseline for Study 2 consisted of the 10 daily quiz scores from Study

1. The intervention phase contained the 10 daily scores from the multiple choice quizzes taken after completing each of the hypermedia study guides. Return to baseline included daily class grades from worksheets and maps the students completed independently in class immediately following the intervention. The A-B-A design was chosen as a means of comparing changes that might occur in individual student quiz score performance across time.

During the daily hypermedia study guide lessons the students worked with the study guide for 30 minutes. They worked independently and were allowed to go through the lessons as many times as possible during the allotted time.

Daily quiz scores of all five students were higher during the intervention phase than during baseline. Furthermore, mean scores for all five students were above the 50% mark indicative of a passing grade. When instruction returned to baseline conditions (the next five regular classroom assignments) daily quiz scores varied with two students decreasing in accuracy and three students increasing in accuracy. This may be due to differences in the nature of assignments between the intervention and return to baseline phase. In the intervention phase the students completed daily quizzes; in the return to baseline phase the

students worked on maps and worksheets with no teacher interaction. The three phases of the A-B-A design, therefore, measured student performance in three different treatment conditions (lecture, hypermedia study guide, independent work). Posttest scores showed an increase for all five students over the pretest scores, and posttest to retention test scores increased for all students except one.

The findings of these two studies suggest that hypermedia study guides are effective, especially for remedial students and students with learning disabilities. Particularly important for these students was the successful retention of information over a two-week period, as indicated by the similarity of posttest scores and scores on retention tests. Evidence of long term retention of information is especially encouraging for this population of students, suggesting that content areainformation read in a hypermedia format can be internalized and retained over time by students with learning disabilities and remedial students.

In an effort to determine which aspects of the hypermedia study guides contributed to students' improved performance, individual features were examined vis a vis test results. The Note function appears to have been particularly effective in conveying factual information (Higgins & Boone, 1990). Item analysis of questions from the study

guides in conjunction with a post hoc statistical test on both the daily quiz scores and scores from retention tests indicated that the factual questions whose answers were displayed through a note window were answered correctly a higher proportion of the time than the inferential questions*, and a similar percentage of the time to the factual questions whose answers appeared in the original body of text. This suggests that, at the very least, the students were making use of the note functions and reading the contents of the windows as carefully as they were reading the main body of text.

On the daily quizzes students answered factual and inferential questions correctly with approximately the same frequency. However, on the retention tests, students answered the factual questions correctly a significantly higher proportion of the time. Based on these data, it appears that the reinforcement provided by the inquiry function promoted short-term retention of inferential information and short- and long-term retention of factual information.

Hypermedia Basal Reader Lessons

The success of hypermedia study guides with remedial students and students with learning disabilities is corroborated by the findings from the first two years of a three-year longitudinal research project

studying the efficacy of hypermedia lessons for basal readers. Primary level students (grades K-3) used hypermedia reading lessons developed for their basal textbooks as a supplement to teacher-led reading instruction (Higgins & Boone, in press; Boone & Higgins, 1990).

The lessons encompass three levels of instructional features: (a) level one, text with enhanced vocabulary; (b) level two, text with enhanced syntactic and semantic structures, and (c) level three, text with built in comprehension strategies. Software developed for the first year of the project included surface level enhancement to the basal reader text. The emphasis at this level was to provide as much additional information as possible for the student to access through the hypermedia format. Computerized pictures, animated graphic sequences, definitions, synonyms, and digitized speech, linked to words and pictures from the original basal text provided the students with new experiences related to reading. The second year software built on the existing software from year one, adding enhancements of syntactic and semantic structures to the same text passages. The new features graphically depicted the relationship between pronouns and anaphora with their referent words. Software developed for the third year adds enhancements for

comprehension and self-monitoring strategies. These include pre-reading guides, questions inserted in text, and page summaries.

The hypermedia basal reader lessons were written in the HyperCard (Atkinson, 1987) authoring system for the Macintosh computer. All computer functions are controlled through the use of a hand-held input device called a mouse, eliminating the need for a keyboard or keyboarding skills.

Comparisons of the reading growth for experimental and control classes as a whole revealed little difference for any of the four grade levels. There was, however, evidence that the use of hypermedia reading lessons was a significant educational help for students identified as "low" by the definitions of reading group placement, achievement test results, or reading rate.

Low students in both kindergarten and second grade experimental classrooms made higher achievement gains than their counterparts in the control classes in letter identification and total reading (kindergarten level) and in comprehension (second grade). Although low students in the first grade experimental class had similar reading gains to the low students in the control class, this was in marked contrast to the significantly higher improvement rates demonstrated by other

students in the control class. This suggests that low students in the first grade experimental class also benefited from using the hypermedia reading lessons.

The success of poor readers with these hypermedia materials at both the secondary and elementary levels is encouraging. Care must be taken in designing hypermedia for poor readers, however, to overcome some potential difficulties in the use of hypermedia materials for this population of students (Balajthy, 1990). It is especially important that hypermedia materials designed for students with limited reading skills be organized so that students will not enter a web of information too complex for them to negotiate effectively. The controlling structure of a hypermedia study guide can provide both an instructional focus and a control over the complexity of the paths available for students to explore. Content and instructional strategies must be coupled with a structure for access that is not confusing to the students for whom the material is developed. Teachers and software developers should consider the access structure of educational hypermedia as well as the content and instructional design when evaluating or designing materials for specific populations of students.

In the hypermedia study guides and basal reader lessons discussed above, effective research-based teaching strategies were incorporated into structured designs that guided the students through information webs more limited in options than usually associated with large scale hypermedia systems (Jonassen, 1990). This instructional assistance provided the support necessary for the poorer readers to be successful with the hypermedia materials.

Text and graphic windows to reinforce vocabulary, graphic depictions of pronoun and antecedent relationships, and comprehension strategies based on inserting questions into the text are hypermedia features that poor readers can understand and use. Elementary school students from a special education resource room indicated through protocol analysis their understanding of the three features listed above that were incorporated into hypermedia lessons based on basal reader text selections (Boone & Higgins, 1990).

Hypermedia Study Guide Development

Creating hypermedia study guides similar to those discussed in this article can be broken down into five basic steps. Each step is listed below with important considerations outlined, but not necessarily listed in the order in which they should be done. As with all instructional

materials, planning the design and selecting the content for a specific population and educational purpose is of the utmost importance.

1. Choose a Hypermedia Authoring System or Language .

Several choices exist for authoring hypertext/hypermedia lessons or informational documents on microcomputers. Key factors in selecting an authoring system or language are the brand of computer one intends to use as a hardware platform for the hypermedia, and the expertise of the individual who will be programming the lesson. The more sophisticated computer hardware systems with large memory capacities, fast processors, and standard connectors for peripheral devices such as hard disk drives, scanners, CD-ROM drives, and videodisc players will provide opportunity for more comprehensive integration of various media into a hypermedia lesson. These machines also run the more powerful authoring software and languages that include more options for programming. Software currently available for creating hypermedia falls into two general classes, menu-driven authoring systems and authoring languages. Authoring languages for the most part offer a high degree of instructional flexibility yet require an equally high amount of computer programming expertise. On the other hand, an authoring system that utilizes menu selection and simple data entry rather than writing

computer code may be less flexible and provide fewer options, but can be programmed by a less proficient computer user.

2. Select and Enter the Main Text Passage. A hypermedia study guide may contain original material as a supplement to a content area text or include verbatim passages that students are required to read from a textbook. All text should be entered in an easy to read typeface without any boldface or italics. Care must be taken not to split meaningful units of text or syntactic structures between pages.

3. Decide Which Words Will Be Hyper-Enhanced. Depending upon the intent of the hypermedia study guide, a decision must be made as to which words or pictures will be enhanced with text, graphics or sound. A hypermedia lesson from a content area text or basal reader might enhance the new vocabulary words, important people or events, timelines, etc. These decisions are the basis for the design of an instructional lesson or the focus of an informational document.

4. Decide the Type of Enhancements. Graphic windows, explanatory or clarifying text, graphic or text combinations, or computer generated speech or music are all options for enhancements in most of the hypermedia authoring systems. The nature of the enhancements (e.g., text, graphic, voice) should be given as much consideration in

designing the study guides as determining which words will be linked to them. A word that is likely to be unfamiliar in print but not in meaning or usage might best be enhanced with a voice pronunciation. A word that is totally new to a student's vocabulary, however, could be defined in text or a picture could be shown as illustration. Keeping the pedagogy of the lessons consonant with the general classroom instruction style is also important. Study guides that are based on an instructional design that stresses recall of factual information may not fit into a classroom in which students regularly are required to write essay-type answers to questions.

5. Identify the Words Which Contain Links to Enhancements. The words that have been chosen as links need to be identified in the main body of text. Three methods that are often used in hypermedia include boldface type, italics, or underlining. These type styles tell the reader that an enhancement exists for that word. In addition to words, many of the hypermedia systems allow graphics to include links to enhancements. A map of the United States for example could contain links to more information about each state by positioning a cursor sensitive area , often called a button, over each state on the map. Specific directions would be necessary in these situations for the reader

to know that the graphic contained the links. Either text, voice, or an icon that had previously been identified to students could be used.

Follow up procedures include checking the study guide for errors, not only spelling mistakes in the text but also errors of logic in the links (e.g., a word is linked to its correct enhancement). Watching students use the study guides can provide useful information such as which type of enhancements the students access most often or how much time they spend viewing a particular enhancement.

Discussion

Computer hardware and software systems available today for developing hypermedia instructional materials are the dream machines of 10 years ago. The fast pace of technology may cause current implementations of hypermedia to be overshadowed by the potential of that which looms in the near future. Huge hypermedia systems linked to global databases including current news events are perhaps a goal for which we should strive, but not at the risk of ignoring the potential of today's technology. Effective educational hypermedia materials can be built now, and should be developed and tested in empirical, research-oriented situations. The possibilities of hypermedia for aiding poor readers, remedial students, and students with learning disabilities is truly

exciting and deserve continued investigation. Using hypermedia to its full potential is a formidable task for education, but one that provides an avenue for creative ideas and the possibility for rewarding results.

* An inferential question was defined as one in which the answer was not specifically stated in the text.

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Authors' Note

Programs that provide hypermedia capabilities or emulation on microcomputers include: (a) HyperCard (Atkinson, 1987)--Macintosh; (b) Guide (Owl Software, 1986) -- Macintosh and IBM; (c) Linkway (Kheriaty, 1989) --IBM; (d) HyperStudio (O'Keefe, 1989)--Apple GS; (e) Tutor Tech (Techware, 1988) – Apple II; Toolbook (Asymetrix, 1990) --IBM; SuperCard (Appleton, 1989)--Macintosh; and (f) HyperScreen (Brackett, 1990)--Apple II and GS.

HyperCard
Apple Computer, Inc.
20525 Mariani Ave.
Cupertino, CA 95014

Guide
Owl International, Inc.
14218 N.E. 21st Street
Bellevue, WA 98007

Linkway
International Business Machines, Corp.
P.O. Box 2150
Atlanta, GA 30055

HyperStudio
Roger Wagner Publishing, Inc.
1050 Pioneer Way Suite P
El Cajon, CA 92020

Tutor-Tech
Techware Corporation
P.O. Box 151085
Altamonte Springs, FL 32715

Toolbook
Asymetrix Corp.
110 110th Avenue N.E.
Suite 717
Bellevue, WA 98004

SuperCard
Silicon Beach Software
9770 Carroll Center Rd., Suite J
San Diego, CA 92126

HyperScreen
Scholastic Inc.
730 Broadway
New York, NY 10003

Table 1. Comparison of daily percent averages.

Table 1: Comparison of Daily Percent Averages

	Treatment Group		
	Lecture	Lecture / Computer Study Guide	Computer Study Guide
Day 1	63	70	83
Day 2	66	71	76
Day 3	65	62	73
Day 4	70	61	73
Day 5	69	70	75
Day 6	75	72	76
Day 7	70	74	76
Day 8	71	81	86
Day 9	76	74	80
Day 10	74	75	80

Note. Scores expressed as percentage correct on 25 item test.

Table 2. Comparison of daily quiz averages.

Table 2: Comparison of Daily Quiz Averages

Educational Group	Lecture	Lecture / Computer Study Guide	Computer Study Guide	Lecture	Lecture / Computer Study Guide	Computer Study Guide	Lecture	Lecture / Computer Study Guide	Computer Study Guide
	Quiz 1			**Quiz 5**			**Quiz 9**		
Students with Learning Disabilities	52	60	74	61	56	66	71	60	72
Remedial Students	61	69	87	63	68	76	68	81	83
Regular Education Students	76	80	89	83	87	83	89	80	84
	Quiz 2			**Quiz 6**			**Quiz 10**		
Students with Learning Disabilities	61	56	70	80	56	62	69	60	76
Remedial Students	57	78	76	61	71	79	65	84	83
Regular Education Students	79	78	82	85	90	87	88	82	80
	Quiz 3			**Quiz 7**					
Students with Learning Disabilities	60	44	62	70	66	64			
Remedial Students	55	70	78	62	73	80			
Regular Education Students	78	71	77	78	82	83			
	Quiz 4			**Quiz 8**					
Students with Learning Disabilities	72	28	58	56	68	74			
Remedial Students	61	71	81	65	85	90			
Regular Education Students	78	83	80	92	89	92			

Note. Scores expressed as percentage correct on 25 item test.

Table 3. Comparison of pre, post, and retention test averages.

Table 3: Comparison of Pre, Post, & Retention Test Averages

	Treatment Group			Educational Group		
	Lecture	Lecture / Computer Study Guide	Computer Study Guide	Students with Learning Disabilities	Remedial Students	Regular Education Students
Pretest	38	42	41	33	40	49
Posttest	68	64	71	56	66	80
Retention Test	62	69	70	56	66	79

Note. Scores expressed as percentage correct on 50 item test.

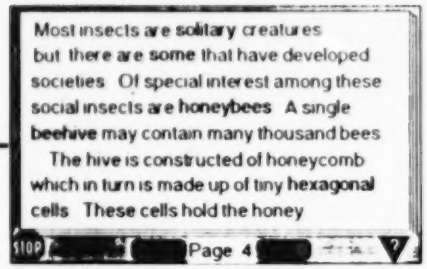
Figure 1. A flow chart detailing the layered structure of hypermedia.

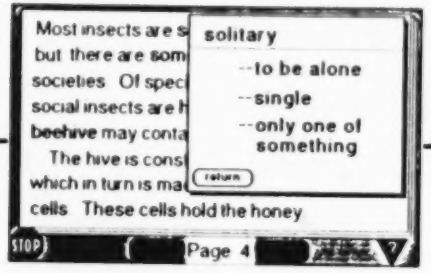
Level 1

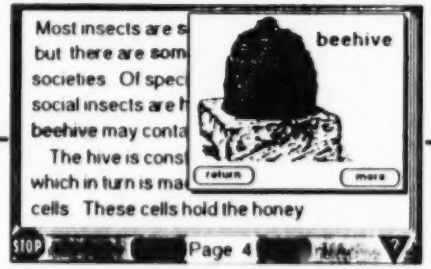
Level 2

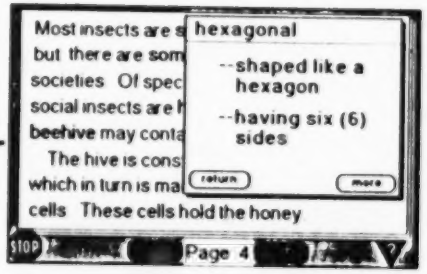
Level 3

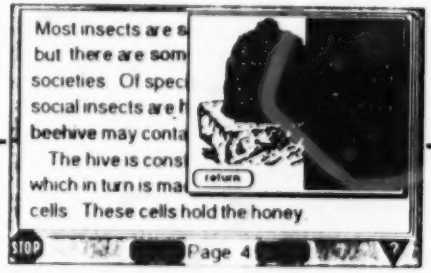
Level 4

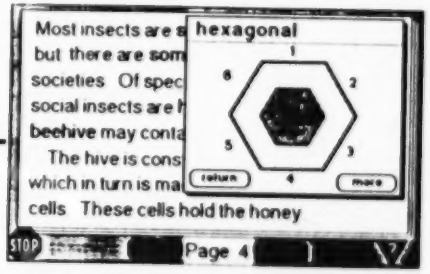

Most insects are solitary creatures but there are some that have developed societies. Of special interest among these social insects are honeybees. A single beehive may contain many thousand bees.
The hive is constructed of honeycomb which in turn is made up of tiny hexagonal cells. These cells hold the honey.
STOP
Page 4
?











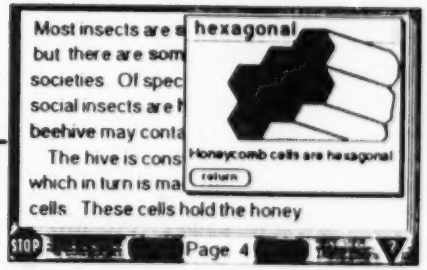


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Figure 2. The structure of a comprehension strategy in a hypermedia study guide.

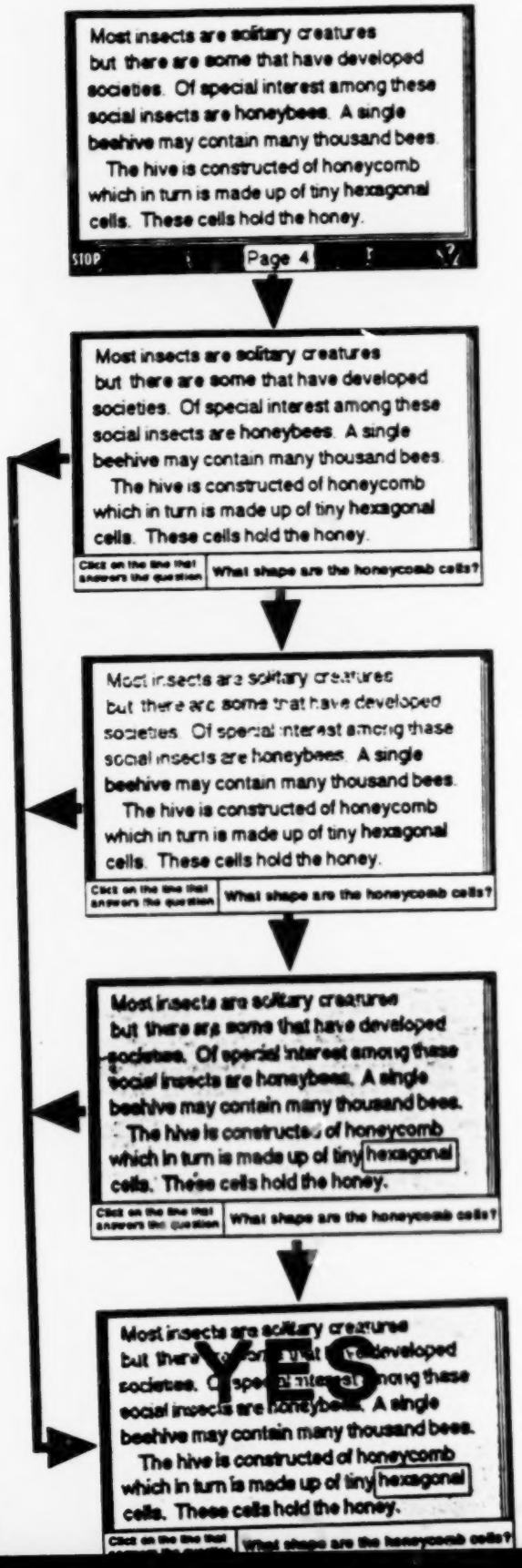

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Figure 3. Hypermedia functions used in the Washington State History study guides.

Wash-10

Who Were the Plateau Indians?

The many groups of Northwest Native Americans who lived east of the Cascades are sometimes called Plateau Indians. Although each group was independent and unique, they shared similar physical environments and cultures. They had somewhat different ways of filling their basic needs than the Coastal people, whose lands and and cultures were different.

The Plateau Indians lived

a. east of the Cascades
b. west of the Cascades
c. in northern Washington
d. in northern Oregon
e. in Montana

ORIGINAL PAGE

Wash-10

Who Were the

The many groups of N

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similar physical envi

different ways of filling t

people, whose lands and and cu

The Plateau Indians lived

a. east of the Cascades
b. west of the Cascades
c. in northern Washington
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e. in Montana

Some of the tribes were the Nez Perce, the Flatheads, the Walla Walla, the Klickitat, and the Yakima.

NOTES APPEAR AS WINDOWS OVER THE TEXT.

Wash-10

N
W EAST
S

The PLATEAU Indians lived here--East of the Cascade Mountains

The Cascade Mountains

Next page

INQUIRIES PROVIDE A QUESTIONING STRATEGY.

Wash-10

Wh ere the Plateau Indians?

The many g ps of Northwest Native Americans who lived east of the Cascad ometimes called Plateau Indians. Although each group was dent and unique, they shared similar physical environments and *customs*. They had somewhat different ways of filling their basic needs than the Coastal people, whose lands and and cultures were different.

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REPLACEMENT OCCURS DIRECTLY IN A LINE OF TEXT.

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